DEVELOPING ENERGY-THEMED TEACHING RESOURCES FOR SCHOOLS – RESEARCH REPORT

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think up

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1.0. INTRODUCTION

Think Up has been asked by the Engineering Construction Industry Training Board (ECITB) to develop a scope of work for the development of a new set of energy-themed teaching resources aimed at raising awareness among 14 to 16-year-olds about the engineering construction sector. ECITB's brief is that these energy-themed teaching resources be aligned to the learning outcomes of a new series of level 2 units called 'An Introduction to Energy' that it has recently developed.

Our starting point for this scoping study was to set this brief within the wider context of the current provision in schools of information, advice and guidance about careers in the engineering sector and to establish implications for the way resources should be developed to achieve ECITB's broader aims of raising awareness of the engineering construction sector. Our next step was to interview a group of teachers and teacher trainers to establish the best way to design a set of teaching resources that would meet their needs. At the same time we have identified specific areas of content that the new resources would usefully address, and researched ways that this content can be delivered.

This report presents the findings of this research and proposes an approach for designing a set of teaching resources that would meet the needs of ECITB and teachers alike. The feedback on this outline proposal will enable us to develop and cost a detailed scope for the proposed resources.

2.0 SETTING THE CONTEXT

In order to design a new set of teaching resources it is important to understand how they will fit into the overall mix of careers stimuli that young people experience during their formal and informal education.

Think Up's 'Whole-Life Skills Model' is a tool that we have developed to help illustrate the interventions which guide, inform and restrict career choices throughout an individual's lifetime. The model is based on an idealised view of a system of interventions (shown in Diagram One overleaf) that would help guide a young person towards the career that best suits them. In this model, we trace the path of individuals with different skills and attributes as they progress through education into their work-life. The ideal view is that individuals best suited to certain sectors of industry end up working in that industry.

In Diagram Two on the following page we illustrate the picture for the engineering construction sector as we see it. In general there is a reasonable supply of careers information related to engineering as a whole although this information does not appear to go into great depth, and the information about engineering construction is patchy and inconsistent. At secondary school level in particular, there appears to be little by way of a coordinated approach to raise awareness of the sector. One challenge that the engineering construction sector faces is that it does not relate in name directly to any GCSE subject, which perhaps makes it less immediately obvious as a career path. The challenge for engineering construction is exacerbated by the large number of institutional bodies that represent this sub-sector, between whom there appears to be little coordination on the provision of teaching resources and support services.

It is clear that in the past large sums have been invested in designing teaching and career resources related to the theme of energy, but as our interviews witheducators indicated these resources appeared to be little-used and not thought of as particularly useful.

Having illustrated in Diagram Two a picture of the resource provision for the engineering construction sector, in Table One we list some of the resources that are available to suit the needs of particular audiences. The comparison is made with the physics sector, which our interviews with educators and our desk research confirmed, is well catered for.

AN IDEAL REPRESENTATION OF WHOLE-LIFE SKILLS DEVELOPMENT

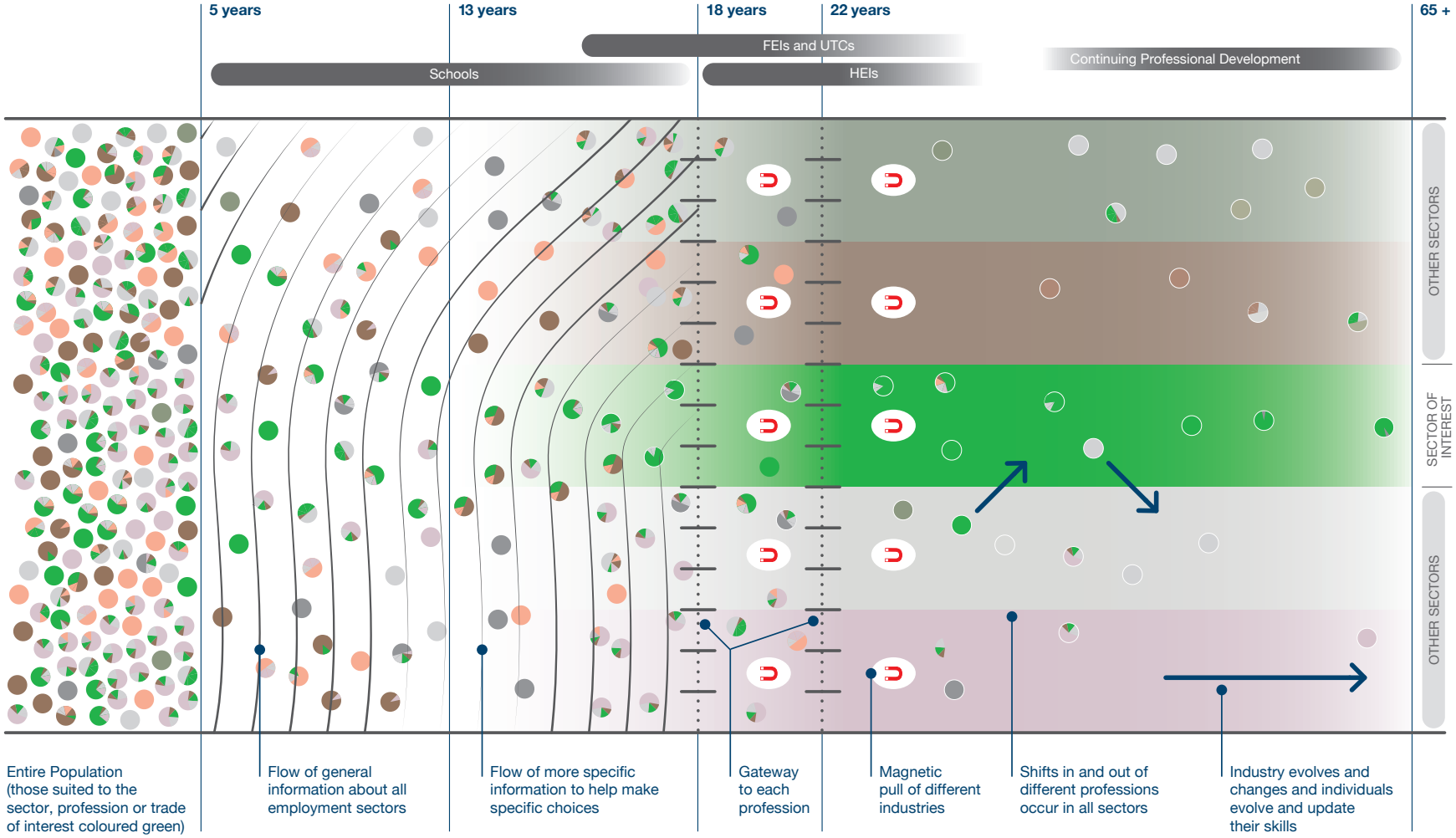

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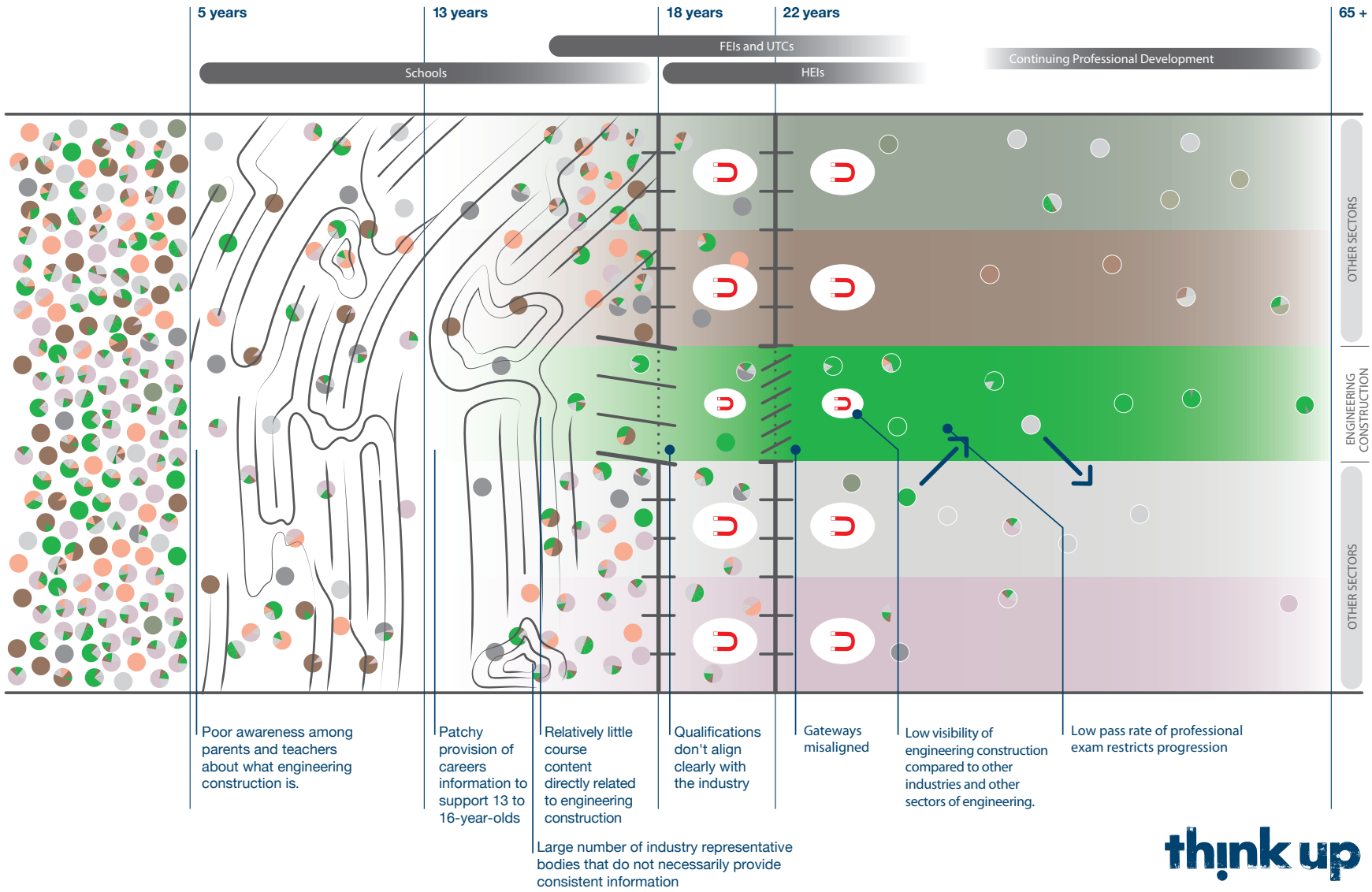
Diagram One - An ideal representation of skills development illustrated using the Whole-Life Skills Model.

THE REALITY – IN THE ENGINEERING CONSTRUCTION SECTOR



Digram Two - An illustration of the current state of information, advice and guidance in the engineering construction sector.

Resoruces type	Physics	Engineering general	Engineering Construction
High-profile sector-related online teaching materials for schools	www.physics.org - student guide to physics on the web www.iop.org - wide-ranging resources for students and teachers alike Practical Physics website - practical experiments for teachers Teaching Advanced Physics website		
Exhibition stands	IOP stand at the Big Bang	RAE Stand at the Big Bang	ECITB Engineering Roadshow ICE stand at the Big Bang IStructE Think Make Test Play stand for the Big Bang
Developing teachers	Schools Affiliation Scheme Physics Teacher Network (over 50 coordinators UK-wide) Talk Physics Educator forum In-service training for teachers	RAE Teacher Support Network	
After-school clubs and extracurricula	STEM club packs STEM Ambassador network	RAE Engineering Engagement Project STEM Ambassador network	
Guidance for parents			
Industrial Liaison	Physics speakers for schools directory		ICE Schools Liaison Officers
Online careers information		Tomorrow's Engineers website	ECITB Careers planner website
Careers Publications			NCE Insite Magazine ECITB Careers planner website
Work experience support			Student Studio (structural engineering and construction site management)

Table One - a comparison between the physics, engineering and engineering construction sectors of information, advice and guidance resources available for specific audeinces.

Implications for the creation of new resources to support teachers

There is a significant need to improve the way that young people find out about engineering construction. Where engineering is not taught as a standalone subject, as is the case at the majority of schools, the science curriculum probably offers the best opportunity for young people to learn about engineering.

While we have been asked to develop resources based on the Introduction to Energy qualification, the more these resources can be developed to support the learning outcomes of the core science GCSE syllabus, which is by far the most popular way to study science, the more learners will potentially hear the message about engineering.

Beyond teaching resources, there are many ways to raise awareness of engineering construction, including: support for STEM clubs; ambassador networks; INSET days for teachers; road shows; careers magazines; and information packs for parents. Arguably a strategy for coordinating the whole spectrum of channels, from teachers to parents, should be established from the outset, so that individual components can be developed that support several channels at once. Establishing a coordinated approach from the outset will also help achieve comprehensive and clear messaging.

3.0. INTERVIEWS WITH EDUCATORS

Having established a picture of the existing provision of information and guidance about careers in the engineering construction sector, we interviewed a group of science educators to test the idea that a set of bespoke energy-themed science teaching resources would be a useful way to raise awareness among students in years 9 to 11 about the engineering sector.

The group of eight interviewees included five teachers who between them teach or have taught science at KS3, GCSE core science and GCSE triple science, and BTEC science. The group included two heads of science departments, one head-teacher, two teacher trainers from the National Science Learning Centre and a Science and Higher Level Skills manager for a sector skills council.

The interviewees were able to provide valuable insights that can help shape the scope of works for the proposed energy-themed teaching resources. The key outcomes from these interviews are summarised below.

Supporting teachers in their work

- The majority of teachers will be using plans of work in their lessons prepared sometimes many months in advance. Depending on the school these plans of work will be off-the-shelf or written by the teachers themselves. Therefore teachers don't need lesson plans.
- Teachers are often looking for additional materials to complement and enhance their plans of work, sometimes right at the last minute.
- Teachers seem to prefer supplementary resources that they can use to quickly engage students in a new topic area, or that can set a piece of theory into a real-life context.
- It can be difficult to find resources about practical applications of science. The old Satis teaching resources were cited several times as being good at doing this, though they are now out of date.
- The IoP and the TES sites are popular places to look for resources about energy. Practical Physics seems to be popular for suggesting practical demonstrations.
- Sophisticated resource platforms, such as those produced by EDF and E-On, don't necessarily appeal to teachers because they do too much of the teacher's work for them, and they are not easy to slot into existing plans of work.
- Teachers have a particular need for resources to support newer topics on the curriculum, such as certain renewable technologies.

Technology

- Schools are becoming more and more IT-equipped; however availability of equipment is still mixed.
- Most schools seem to have access to multimedia projectors in classrooms, if not Smart boards. Resources that can be quickly deployed on these devices, or printed off if needs be, seemed popular.
- Requiring students to use certain websites at home had a mixed response. For some teachers, this is another excuse for students not to do the work. For others, it is something that they are experimenting with. It is not a commonly used approach at the moment.
- Videos can be popular, but they should be suited to their audience, which they often aren't.

Linking teaching resources with careers

- It is important to make students aware of engineering in Year 9 as this is when students are choosing their GCSE options.
- Energy is a very appropriate topic for introducing students to engineering construction because: it is a topic that is covered at many levels; it is a topic that is easy to put into an everyday context; it is full of potentially exciting subject matter.
- Evidence suggests that linking theory to practical application and careers can help students engage with more complex theory. With the demise of Connections services, schools are also required to provide more information on careers. Bringing more careers information into teaching is therefore a good idea.
- National STEM week is another opportunity to offer careers advice, but schools must opt into this scheme.

Distribution

- There is no one dominant way that teachers find out about potentially useful teaching resources. The teachers we spoke to were unaware of the very sophisticated teaching resources that we found online produced by energy companies.
- Word-of-mouth recommendations seem to be an important part of how teachers find out about resources
- The most common places to look online seem to be simply doing a Google search for resources that meet their needs, or looking at what has been recommended by other teachers on the TES website.
- Exam boards provide lists of recommended teaching resources, which are referred to by some teachers.
- The National STEM library is another place that people look for teaching resources, and it has a good archive.
- STEMNET distributes resources for after school clubs.

Offering alternative awards

- Where GCSEs are already being taught it is unlikely that additional material will be covered in lesson time in order to work towards additional awards. In such cases after-school science learning clubs are a good opportunity to cover additional material, and teachers often don't have time to create structured activities for these classes.
- Where the BTEC in science is being taught, there is a little more scope to incorporate additional content so that students can work towards an additional award.
- Schools' appetite for offering non-GCSE modules to students varies dramatically, and is probably influenced by: socio-economic factors in the local area; whether schools want to offer additional qualifications in order not to lose out to FE colleges in the post-16 sector; and how risk-averse the school is to offering additional non-GCSE qualifications, which may not count towards league table points, and which the current government has sent strong signals that it does not endorse.

4.0. REVIEWING THE SUBJECT MATTER

We were originally asked to look at how the Introduction to Energy units that ECITB has recently produced could be used as the basis for the proposed new set of teaching resources for schools. The Introduction to Energy award is made up of five units. Four of the units are technical in nature; the fifth unit is about career planning.

As part of our research we have compared the content of the technical units in the Introduction to Energy course with the energy-related subject matter in the curricula of courses that the majority of students in Year 9 to Year 11 are currently enrolled in:

Year 9

Key Stage 3 of the National Curriculum

Year 10 & 11

GCSE core science
GCSE additional science
GCSE triple science
BTEC 1 and BTEC 2.

The detailed comparative tables are provided in the appendix. The key findings from this comparison exercise are:

- The energy-related content across these curricula can be broadly grouped into five themes: energy theory; electrical theory; energy generation and sustainability; transmission and the grid; domestic use and efficiency.
- Units 1 and 2 of the Introduction to Energy syllabus have many things in common with the Core Science GCSE syllabus.
- Units 3 to 4 of the Introduction to Energy syllabus take the themes from Unit 1 and develop them in more depth; however they have much less in common with any of the other syllabi.
- While the themes of energy theory and electrical theory feature strongly in the GCSE and BTEC syllabi, these themes do not feature strongly in the Introduction to Energy Units.
- BTECs are designed to be inherently more contextual and applied than GCSEs, with a clearer distinction between application and theory. There is a clear overlap between the application elements of the BTEC science syllabus and the Introduction to Energy syllabus.

As well as comparing content, it is useful to compare the amount of time that students are expected to spend working towards these qualifications. In this respect the easiest point of comparison is between Unit 1 of the Introduction to Energy syllabus, and the equivalent parts of the Core GCSE Science curriculum. The specified guided learning hours (GLH) for Unit 1 of Introduction to Energy is 40; our research indicates that teachers delivering the Core Science GCSE would spend approximately 10 GLH on equivalent topics. In other words, where there is content overlap between the GCSE and the Introduction to Energy syllabi, students studying the latter are expect to take four times as long doing so than the students doing the former.

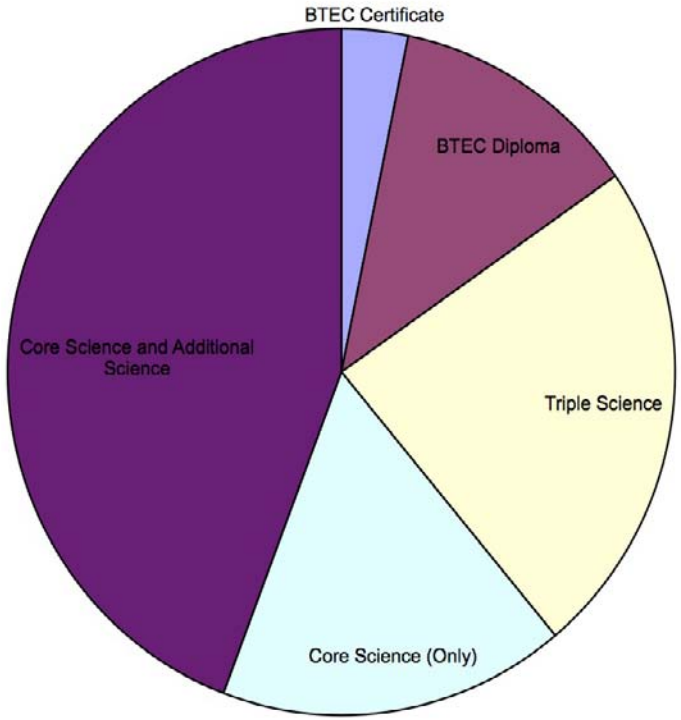


Chart One - showing the proportion of students enrolled in different science courses at KS4 - Source, DfE.

5.0. DEFINING USER GROUPS AND THEIR NEEDS

Combining the findings of our interviews with educators and analysis of the curricula, we can characterise a number of teacher user groups for these resources and their needs.

Key Stage 3 Science Teachers

Teachers delivering Key Stage 3 science are perhaps in less of a hurry than GCSE teachers, and can be slightly more flexible in their delivery. They are likely to be teaching to plans of work prepared months in advance, but may be seeking additional information to get students' attention when introducing a topic. As students start to think about career choices at Key Stage 3, this is a good time to introduce careers information into teaching. Energy is introduced at this level by talking about different types of energy; calculations are saved for Key Stage 4. Compared with the GCSE syllabi, teachers are freer to choose contexts within which to develop students' scientific skills.

GCSE Science Teachers

We found from the teacher interviews that teachers delivering GCSE science often need an introductory resource to quickly grab students attention. There are existing plans of work that will help them deliver the majority of the content. They are also looking for ways to put the science in context, or to provide careers information. Therefore, a set of attention-grabbing easy-to-use introductory resources that help put the science of energy into context are likely to be useful for these teachers. These teachers are usually in a hurry to get through what's on the syllabus, so there is little scope for introducing off-syllabus topics. Much more in-depth resources are likely to be much less useful for this group.

BTEC Science Teachers

Teachers delivering the BTEC courses are under less time pressure than GCSE teachers and so they have more scope to introduce more in-depth activities. Given the clear distinction between theory and application, BTEC teachers will benefit more than GCSE teachers from resources that describe application in detail. There are significantly fewer resources available online targeted for this audience, and so they stand to benefit more from the creation of such resources.

Facilitators of after-school science clubs

There is an interim group of teachers who want to support students doing further study into energy outside of classroom time, for example in after-school STEM clubs. In these circumstances, the learners are likely to need to be given much more structured support.

Introduction to Energy teachers

The small number of teachers delivering the new Introduction to Energy teaching resources are unlikely to have established plans of work in place, and so more in-depth resources are likely to be needed by this smaller group.

6.0. RECOMMENDATIONS FOR THE DESIGN OF ENERGY-THEMED TEACHING RESOURCES

In the schools sector there a number of potential audiences for energy-themed teaching resources, requiring resources that go into varying depth. The largest audience is GCSE Science teachers with a need for discrete attention-grabbing resources that can be used to introduce new topics in their lessons. In contrast, the smallest audience is likely to be the teachers delivering the Introduction to Energy modules as these are brand new. This latter group needs the most in-depth support, again, as the qualification is new.

Faced with a range of audiences and differing needs, we recommend a coordinated approach that allows use by all potential audiences to the depth that they need. Common to all the courses that teacher audiences are delivering are five content themes: energy theory; electrical theory; energy generation and sustainability; transmission and the grid; domestic use and efficiency.

Our proposed approach therefore would be to develop for each of these themes a key high-profile attention-grabbing introductory resource that can be used as an exciting way in to each theme, no matter what qualification is being followed. Building from each introductory resource would be a range of potential follow-up resources, which support teachers going into as much depth as they need.

This approach has a number of advantages:

- The high-profile attention-grabbing introductory resources will help raise the profile of the resources and help to overcome the challenge of dissemination among teachers.
- These headline resources will be of benefit for all audiences.
- The follow-on resources can be developed in whatever order is preferred, depending on which audience is prioritised. For example, we could choose to develop sufficient resources to support delivery of Unit One of the Introduction to Energy units first.
- This theme-based framework can be used as the basis for other resources, such as training packs for teachers, info packs for parents etc.

The approach is illustrated on the next page, and a description of how it could be applied in practice is given in the grey box to the left.

In Diagram Three we illustrate how taking the recommended approach can help improve the overall process by which young people are guided towards the engineering construction sector. In Table Two we show how this approach can be used to fill in some of the gaps in the provision of specific resources for different audiences.

EXAMPLE
TRANSMISSION AND THE GRID

For this theme, the headline resource could be a map of the National Grid that shows realtime data about energy use. In its own right, this is the sort of resource that teachers could use to introduce students to the concept of the national grid, and the importance it plays in supplying electricity to individual homes.

The map itself could be used as a key for finding a host of related information and resources related to this theme. Clicking on particular parts of the grid map could link to photographs of particular features, for example: step up and step down stations; transmission towers; power stations; suburban distribution stations.

An offline version could be provided for teachers who don't have internet access in classrooms. Also mapped to parts of the grid could be information about specific jobs that people do designing and maintain the grid. These pages in turn could link to the relevant pages on the ECITB careers website. Similarly, the link could be made with the bits of the curriculum that are required to design or operate a certain part of the grid. For example, at the transformer station, students can be reminded of the turns equation for calculating voltage changes in transformers.

Accompanying this resource would be a range of follow-up activities that would allow students to go into more depth. For example, a game for students to play where they have to manage the grid; alternatively a role-play activity in which students have to take on the role of different people involved with designing and operating the grid.

At the most in-depth level would be a programme of activities, reading materials and quizzes that would support students studying for Unit One of the Introduction to Energy qualification.

As the illustration shows, from one introductory resource, a whole set of support interventions can be created, that start to fill in the gaps that were identified in Table One towards the start of this report. Table Two illustrates how these gaps could start to be filled in.

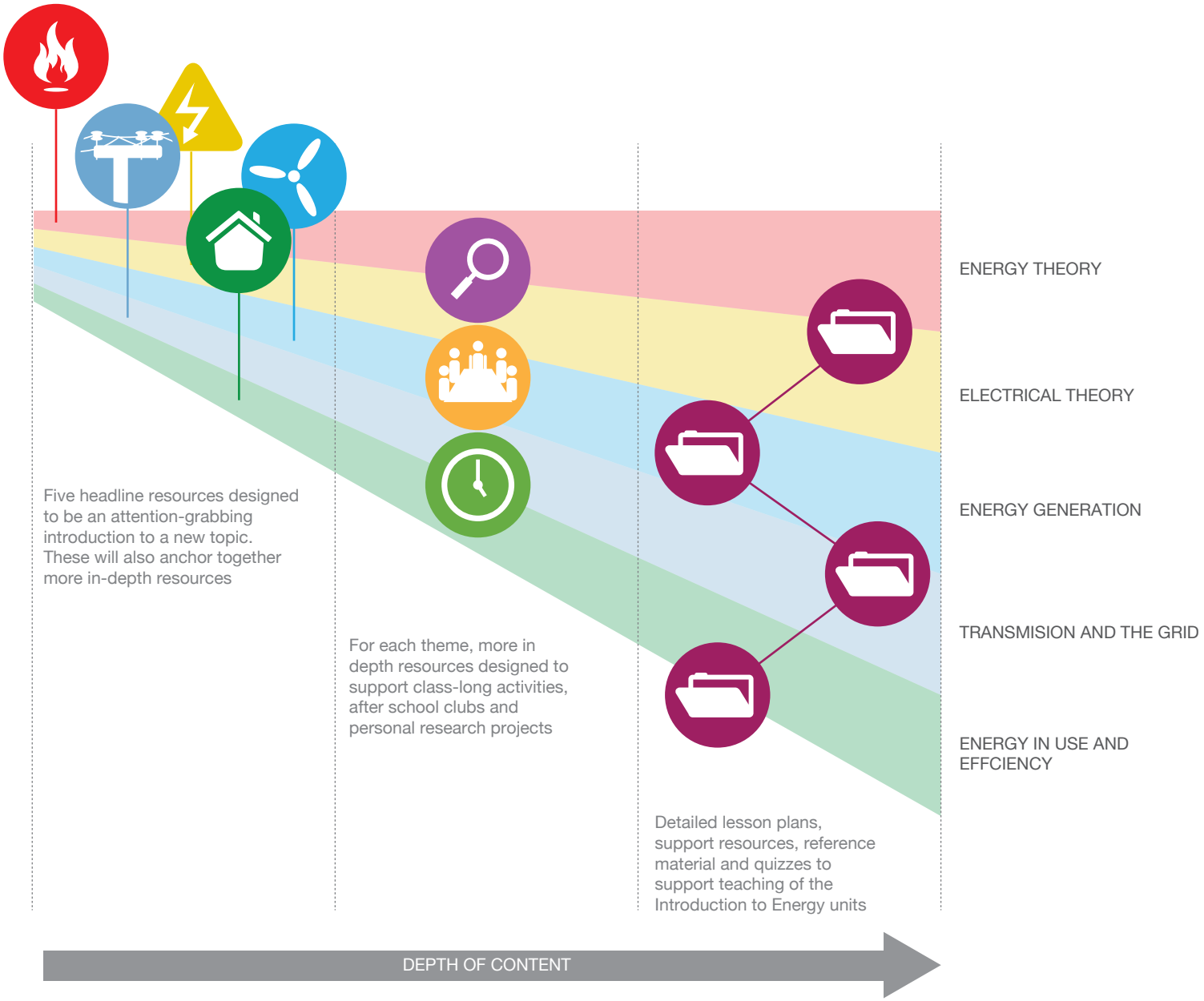
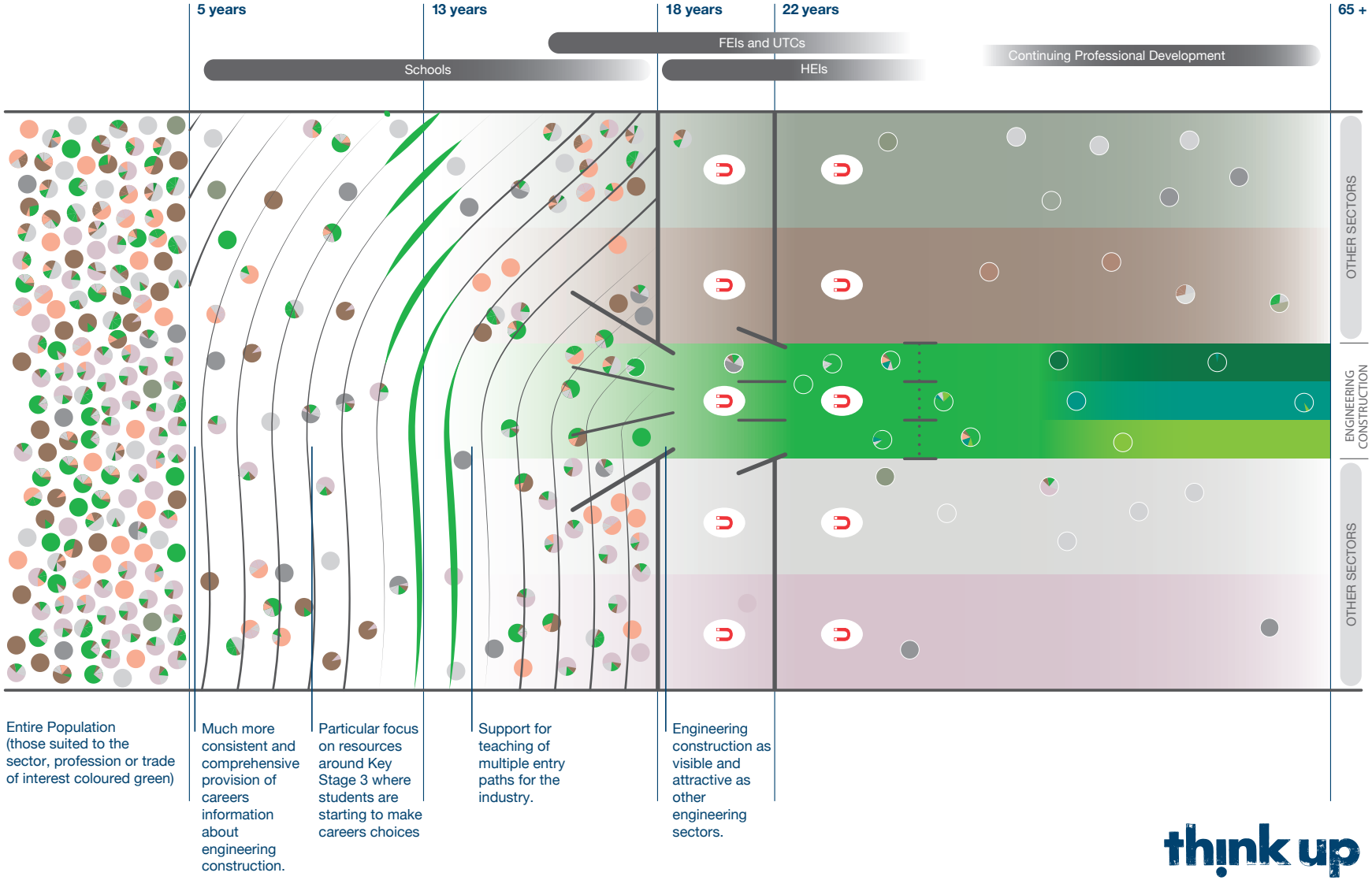

ENERGY THEORY
ELECTRICAL THEORY
ENERGY GENERATION
TRANSMISION AND THE GRID
ENERGY IN USE AND EFFCIENCY
Five headline resources designed to be an attention-grabbing introduction to a new topic. These will also anchor together more in-depth resources
For each theme, more in depth resources designed to support class-long activities, after school clubs and personal research projects
Detailed lesson plans, support resources, reference material and quizzes to support teaching of the Introduction to Energy units
DEPTH OF CONTENT

DIAGRAM THREE
AN IMPROVED VIEW OF INFORMATION PROVISION IN THE ENGINEERING CONSTRUCTION SECTOR



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Resoruces type	Physics	Engineering general	Engineering Construction
High-profile sector-related online teaching materials for schools	www.physics.org - student guide to physics on the web www.iop.org - wide-ranging resources for students and teachers alike Practical Physics website - practical experiments for teachers Teaching Advanced Physics website		Energy-themed teaching resources - support for all modules at at KS3 and KS4 A web portal for the latest engineering construction information from the web
Exhibition stands	IOP stand at the Big Bang	RAE Stand at the Big Bang	ECITB Engineering Roadshow ICE stand at the Big Bang IStructE Think Make Test Play stand for the Big Bang Engineering Construction mobile exhibition stand on the theme of generating electricity for future generations
Developing teachers	Schools Affiliation Scheme Physics Teacher Network (over 50 coordinators UK-wide) Talk Physics Educator forum In-service training for teachers	RAE Teacher Support Network	A network of ECITB partner schools In-service training for science teachers about engineering
After-school clubs and extracurricula	STEM club packs STEM Ambassador network	RAE Engineering Engagement Project STEM Ambassador network	Energy-themed after school club activites based on 'Intro to Energy' qualification Worksheets for STEM ambassadors based on energy-themed teaching resources
Guidance for parents			Careers information for parents about career routes for engineers
Industrial Liaison	Physics speakers for schools directory		ICE Schools Liaison Officers
Online careers information		Tomorrow's Engineers website	ECITB Careers planner website
Careers Publications			NCE Insite Magazine
Work experience support			Student Studio (structural engineering and construction site management) Energy-themed Student Studio projects for work experience in the engineering construction sector

7.0.
NEXT STEPS

In this report, we have presented our research into the context within which a new set of energy-themed teaching resources would be used, and the needs of the users. We have proposed an approach for shaping a set of resources that can meet the needs of multiple audiences.

In the final stage of this scoping project we will agree with ECITB the audiences at which the proposed teaching resources should be aimed and the level of depth they should go into. Think Up will then assemble and cost a detailed schedule of resources to meet this brief.

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